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RESEARCH NOTE

Canal Irrigation and Collective Action: The Case of Water User Associations in Southern India

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ABSTRACT

Policies of devolving management of resources from the state to user groups like water users' associations in India are premised upon the assumption that users will organize and take on the necessary management tasks. As devolution movements become widespread, that affects the management of land, water and forest resources as well as the livelihoods of millions of people, it becomes essential to examine the experience of such programs. The present paper analyses the different aspects of participation of farmers in canal irrigation by taking 40 water users' associations in South India.

Keywords: Canal Irrigation Management, Collective Action, Water User Association, Southern India

JEL: Q12, Q15, Q25.

I

INTODUCTION

The process of devolution of resource management involves programmes that shift responsibility and authority from the state to non-governmental bodies or user groups (Meinzen-Dick *et al*. 2000)—a "rolling back the boundaries of the state" (Vedeld 1996). Ostrom (1990) thus promoted Community Based Natural Resource Management (CBNRM) as a viable institutional alternative where community-based organisations like Water User Associations (WUAs) were created to take care of Operation and Maintenance (O&M) activities of public irrigation systems (Dewan *et al.*, 2014).

Although India has a long history of farmer-managed irrigation systems, the beneficiary participation is however, found to be poor in India (Joseph, 2001). It would appear that Kerala lags behind the all India performance level in the extent of farmer's participation in irrigation management. In addition, Kerala has no reported tradition in the management of irrigation systems by farmers (Joseph, 2001). Hence, it becomes essential to examine the experience of such programmes.

However, much advancement in transferring irrigation management responsibilities to farmers could be seen in Kerala in the minor irrigation sector (Chackachery, 2014). But, attempts have been made to ensure the participation of farmers through the establishment of WUAs in the command areas. Even though there are several contributing factors for the implementation of participatory

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irrigation management (PIM) in the state like better literacy rate and education status of farmers of Kerala the PIM activities are not properly continued during the post-turn over phase in Kerala. Keeping these issues in view the present paper focus on the extent of household participation and its impact on farm revenue. The specific objectives are: (1) To identify the factors that affect the type (labour/money) and amount of participation by farm households and (2) To study how are the variables input purchases and farm revenues influenced by factors driving the participation decision.

II

STUDY AREA AND DATA

To study the extent of household participation in canal WUA, Palakkad district was purposively selected since the district has maximum number of canals and large number of WUAs. The Kanjirapuzha Irrigation Project (KPIP) has been purposively selected, to study functioning of WUAs because Command Area Development Authority (CADA) programme is being implemented in four projects out of which KPIP is one among them.

A list of all WUAs within the command area of KPIP project was obtained from the CADA. From the list, a sample of 40 WUAs (20 functioning and 20 non-functioning) were randomly selected to study in depth the performance of WUAs, the type and extent of household participation of the members in various canal maintenance activities. Proportionate random sampling procedure was employed to study the farm households. As the size of WUA varies across the type of structures, 20 per cent of the farmers were randomly selected and studied from functioning and non-functioning WUAs for the purpose. A sample of 142 farm households were selected in functioning WUAs and 131 farm households were selected in non-functioning WUAs. The structure, functioning and performance of WUA was studied to identify suitable policy options to enhance the effectiveness and improve its working. Thus a total sample of 273 farm households were selected and studied. In addition, village elders, local leaders and few knowledgeable persons in the concerned area, some beneficiary farmers and office bearers of WUAs for canal water management were interviewed. The information was also gathered through informal interviews with Command Area Development Authority (CADA) officials consisting of engineers, agricultural officers and co-operative personnel.

III

METHODOLOGY

Conceptual Framework

The conceptual framework of the present study draw insights from the work of Ostrom (1992) and Tang (1992) who have identified factors which contribute to

effective self-managed irrigation systems, focusing on the physical attributes of systems, the attributes of the community of users, and rules or institutional arrangements. Ostrom's (1992) design principles of long-enduring, self-organised irrigation systems included clearly defined boundaries, proportional equivalence between benefits and costs, collective choice arrangements (users' ability to set and modify rules), monitoring, graduated sanctions, conflict resolution mechanisms (at least minimal recognition of rights to organize) and nested enterprises (federations). Non-functioning WUAs has been selected to analyse the performance of WUA when compared to functioning WUA. Analysing functioning WUA alone do not lead to reliable results.

Based on this theoretical background, the framework suggests that collective action outcomes of the functioning WUAs are shaped by the different factors of Water User Association which in turn is affected by the transaction cost that they incur. The household participation in WUA is in turn influenced by various factors (a) WUA characteristics (group size i.e GSZE [number of members in WUA], gini coefficient [GINI, economic heterogeneity i.e. farm size of each WUA]) (b) household level factors (age of the household head in years [AGE], education of the household head [EDUCATIONH], farm size [FSIZE], location of the field [LOCATION, 1=member, 2=office bearer], role of the members in WUA [ROLE, 1=member, 2=office bearer] and non-farm income [NFINCOME in Rs./yr]) (c) Community level factors (infrastructure index[1]). These factors can exert an influence on incentive structures along with other independent variables.

The functioning water user association receives incentives like seeds and fertilisers in addition, from CADA which in turn increase their participation in yearly operation and maintenance activities of canal whereas the non-functioning WUAs do not receive any incentives. Any economic activity could be organised through different institutions, and implicit in any institution, there exist problems of contracting and associated procedures between the actors. The pattern of interaction among the different actors and activities is to be accounted while analysing the performance of WUA.

Empirical Framework

Modelling Participation and Contributions

This study is primarily concerned with (a) evaluating the household, user group and community-level factors that affect a household’s decision to participate in yearly canal maintenance activities and (b) examining how variables that influence the contribution process also affect purchased input choices and farm revenues.

The outcome variable for the first objective is the number of labour hours/money contributed. To analyse the first step of the problem, consider the possibility that an underlying decision process may directly influence the amounts contributed to each

activity. Certain households may be more inclined to give labour rather than money, or vice versa. It could be observed from the survey that poorer households appear to informally substitute labour for money, and vice versa. The members who are more likely to benefit from WUA participate and are in turn more likely to be observed members. To correct for this potential selection bias, a Heckman two-step estimator is employed to model each contribution process (Coady *et al.* 2001). In the first stage, a probit regression is specified for the binary decision to contribute labour or money:

$$d^* = X\gamma + u_i \quad \ldots.(1)$$

$d = 1$ if $d^* > 0$, 0 otherwise

where X is a vector of exogenous household, community, and WUA characteristics influencing the participation decision and is an error term with mean 0 and variance 1. This allows to calculate a household specific selectivity variable (Inverse Mill's Ratio, λ) with which the self-selection bias can be addressed using the Heckman two step approach. The Heckman-type selection models (Heckman 1974, 1976, 1979) are appropriate only when at one "extra" explanatory factor influences selection but not the subsequent outcome of interest (Achen 1986, Sartori, 2003). The Inverse Mill's Ratio, λ, which measures the probability of the household being a participator, is used to address self-selection bias. The IMR is used as an additional regressor. It is calculated for each observation of the selected sample from the first stage of Probit estimation. If the coefficient of the IMR is found to be significant, sample selection bias really exists and, including IMR as an additional regressor is relevant and increases efficiency. Contrarily, insignificant effect of the IMR indicates no such sample selection bias is detected (Dutta and Magableh, 2004). i.e. In the first step, a household specific self-selection variable λ is estimated with the following Probit model.

$$\text{Prob (PARPN = 1)} = \beta\,'K + e_i \quad \ldots.(2)$$

From which $\lambda = \varphi(\beta\,'K) / 1 - \Phi(\beta\,'K)$

where K is a set of variables explaining the participation decisions, φ and Φ are the probability density and cumulative distribution of the error term respectively. The second stage then uses OLS to estimate the level of contributions $C^* = X\beta + v_i$ where X is a vector of exogenous household, community, and WUA characteristics influencing the participation decision and v_i is an error term. It is assumed that u_i and v_i take on a bivariate normal distribution $(u_i, v_i) \sim N(0, 0, 1, \sigma^2, \rho)$ and ρ is the correlation between the error terms. In the second step, the Inverse Mills Ratio (IMR) obtained from the estimation of the first equation is used an explanatory variable to account for selectivity bias. Statistical significance of the t-statistic on the IMR variable in the second stage supports the conjecture of selection bias in the sample.

Hence, the study uses three Heckman two-step estimators to model the contribution process of labour or money. The model is specified as follows:

$$\text{PARPN}_i = \beta_0+\beta_1\text{GSIZE}+\beta_2\text{GINI}+\beta_3\text{AGE}+\beta_4\text{EDUCATIONH}+\beta_5\text{LFIELD}+\beta_6\text{FSIZE}+\beta_7\text{ROLE}+\beta_8\text{NFINCOME}+\beta_9\text{MEETING}+\beta_{10}\text{INFINDEX}+e_i \quad \ldots.(3)$$

$$\text{CONTRIBUTION}_i = \beta_0+\beta_1\text{GINI}+\beta_2\text{AGE}+\beta_3\text{EDUCATIONH}+\beta_4\text{LFIELD}+\beta_5\text{FSIZE}+\beta_6\text{ROLE}+\beta_7\text{NFINCOME}+\beta_8\text{INFINDEX}+\beta_9\text{MEETING}+\beta_{10}\lambda+\varepsilon_i \quad \ldots.(4)$$

Purchased Inputs and Farm Revenues

To determine how the exogenous household and community-level characteristics influence variable input purchases and farm revenues, the reduced form solutions (equations 5 and 6) are transformed into a modified linear regression model:

$$k_i = \beta_0 + \sum\beta_i\ \text{H}_i + \sum\beta_j\ \text{C}_i + \sum\beta_m Z^{WUA} + \varepsilon_i \quad \ldots.(5)$$

$$\pi_i = \beta_0 + \sum\beta_i\ \text{H}_i + \sum\beta_j\ \text{C}_i + \sum\beta_m Z^{WUA} + \varepsilon_i \quad \ldots.(6)$$

where k_i is the input expenditures per hectare (seeds [SEEDS] and fertilisers [FERTILISERS] that the farmers receive in Rupees), farm revenues [REVENUE] in rupees per year per hectare (Y_i) from the six primary crops grown among households in the sample (rubber, paddy, banana, coconut, arecanut and cucumber), and ε_i is a stochastic error term. The factor expenditure equation and farm revenues are modeled using ordinary least squares (OLS) with adjusted standard errors for clustering at the WUA level. Since households grow a wide variety of different crops and such crops do require different investments and input requirements, gross returns per hectare is aggregated. Hence the following model was estimated.

$$\text{SEED} = \beta_0+\beta_1\text{EDUCATIONH}+\beta_2\text{GINI}+\beta_3\text{AGE}+\beta_4\text{MEETING}+\beta_5\text{LFIELD}+\beta_6\text{FSIZE}+\beta_7\text{ROLE}+\beta_8\text{NFINCOME}+\beta_9\text{INFINDEX}+\beta_{10}\text{GSIZE} \quad \ldots.(7)$$

$$\text{FERTILISER} = \beta_0+\beta_1\text{EDUCATIONH}+\beta_2\text{GINI}+\beta_3\text{AGE}+\beta_4\text{MEETING}+\beta_5\text{LFIELD}+\beta_6\text{FSIZE}+\beta_7\text{ROLE}+\beta_8\text{NFINCOME}+\beta_9\text{INFINDEX}+\beta_{10}\text{GSIZE} \quad \ldots.(8)$$

$$\text{REVENUE} = \beta_0+\beta_1\text{EDUCATIONP}+\beta_2\text{GINI}+\beta_3\text{AGE}+\beta_4\text{MEETING}+\beta_5\text{LFIELD}+\beta_6\text{FSIZE}+\beta_7\text{ROLE}+\beta_8\text{NFINCOME}+\beta_9\text{INFINDEX}\beta_{10}\text{GSIZE} \quad \ldots.(9)$$

Hence for the present study inequality in terms of farm size of each WUA was estimated. The data on farm size of each of the members in WUA was obtained from the records of the association. Gini Coefficient for the ayacut area of each WUA as a

use group characteristic for each WUA was calculated. The gini coefficient thus calculated endured the same for the number of farmers selected from each of the WUA.

IV

RESULT AND DISCUSSION

General Characteristic of the Households

An understanding of the household characteristics is important to contextualise farmers' behaviour in irrigation management. Table 1 provides basic features of the sample respondents.

TABLE 1. GENERAL CHARACTERISTIC OF THE HOUSEHOLDS

Particulars	Members	Non-members	Overall
(1)	(2)	(3)	(4)
Average size of the family	5.03	4.65	4.84
Number of workers per family	2.13	1.83	2.03
Average age of head of the family (years)	51.40*	57.82	55.67
Average educational status	2.95 ***	1.95	2.91
Average farming experience (years)	27.81**	25.19*	26.5
Average farm size (hectares)	2.73	2.67	2.70
Non-farm income(Rs. lakhs/year/household)	0.60	0.51	0.55
Off-farm income (Rs. lakhs/year/household)	0.43	0.25	0.34
Gross cropped area	2.88***	2.63	2.52

Note: Figures in parentheses indicate per cent to total, ***, ** and * indicate values are significantly different at 1, 5 and 10 per cent levels from the corresponding values of non-members.

The results given in the table indicated that average size of the family in both the categories were nearly five. It was also observed during the survey that at least two members among the farm household were engaged in the canal maintenance activities or the agricultural operations. The average family size among the respondents of members in WUA is five. Among the sample respondents, number of workers per family was one in the case of non-members and two in the case of members. This indicated that some of the farm households' are dependant on hired labourers for various operations.

Cropping Pattern

Cropping pattern followed by sample farmers is given in Table 2. The crops like paddy, coconut, arecanut, rubber, vegetables and banana were the major crops grown by the sample respondents. It was revealed that in the head area commercial crops were more cultivated whereas food crops were mostly cultivated in the middle and the tail areas. An important fact to be noted was that in the tail area mixed crops were also cultivated substantially.

TABLE 2. CROPPING PATTERN IN SAMPLE FARMS

(*ha*)

Sl. No. (1)	Crop (2)	Members (3)	Non members (4)
1.	Paddy	2.40	2.25
		(83.33)	(85.55)
2.	Coconut	0.17	0.15
		(5.90)	(5.70)
3.	Arecanut	0.09	0.09
		(3.10)	(3.42)
4.	Rubber	0.08	0.05
		(2.77)	(1.90)
5.	Vegetables	0.06	0.02
		(2.08)	(1.66)
6.	Banana	0.07	0.07
		(2.43)	(2.66)
	Gross cropped	2.88***	2.63
	Area	(100.00)	(100.00)

Source: Primary household survey (2014-2015).

Note: Figures in the parentheses represent percentage of total to the gross cropped area; ***, **, * indicates values are significantly different at 1, 5 and 10 per cent level from the corresponding values of non- members.

Among the members of WUA paddy occupied 83.33 per cent of the gross cropped area. Similarly, paddy formed the major crop among the non-members of WUA which accounted for 85 per cent.

Location in the Command Area

Each of the canal commands can be been classified into three - head, middle and tail reaches, based on the water distribution characteristics. The reach closer to the water source is designated as head and the lower most reach as tail and the reach in between as middle (Table 3).

TABLE 3. LOCATION OF THE FIELD IN THE COMMAND AREA

Location (1)	Number of farmers (2)	Percentage (3)
Head	49	34.50
Middle	43	30.38
Tail	50	35.21
Total	142	100.00

Source: Primary household survey (2014-2015).

One of the most important factors that influenced the farmers in their irrigation behavior was the location of their land within the command area. Farmers in the head reach were normally considered as privileged since they got water more regularly; the tail-end farmers were really deprived of water.

Reliance of Farmers on WUA

As mentioned earlier, farmer associations function at the base level of the three-tier system of CADA were instituted for ensuring participation of farmers in irrigation management.

According to farmers, the major use of farmer associations has been, (i) reduction in the cost of production due to cooperative ventures; and (ii) ensuring the better distribution of water. This point towards the necessity for improving the performance of the farmer associations to ensure participation of farmers in irrigation management. Table 4 provides findings on the role of the farmers on irrigation institution. About 91 per cent of the farmers indicated that they relied on the WUAs sustainability.

TABLE 4. RELIANCE OF THE FARMERS ON THE IRRIGATION INSTITUTION

Participation	Number of farmers	Percentage
(1)	(2)	(3)
Very substantial	5	3.52
Substantial	130	91.54
Very little	7	4.92
Total	142	100.00

Source: Primary household survey (2014-2015).

Meetings Organised by WUA

Many of the problems related to irrigation are solved directly by farmers themselves. It is mandatory that members should meet at least once a year to discuss problems, make decisions and to elect new executive committee. However, in practice, it is hardly the case (nearly two meetings). It seems that the only occasion that brings farmers and WUA to meetings is when they negotiate on the issues like cleaning of the canals, when the irrigation system ceases to function or when an urgent action is needed (Table 5).

TABLE 5. DETAILS OF THE MEETINGS ORGANISED BY WUA

	(1)	(2)
A.	Average Number of Executive Meetings held	1.85
	Average meeting participation rate (per cent)	82.80
	Average time spent for meeting per year (hr)	1.57
B.	Average Number of General Body Meetings held	2.50
	Average meeting participation rate (per cent)	75.75
	Average time spent for meeting per year (hr)	1.23
C.	Average Number of Specific Problem Meetings held	1.30
	Average meeting participation rate (per cent)	81.66
	Average time spent for meeting per year (hr)	1.00
D.	Average total No. of meetings held(no./yr)	1.83
	Average meeting participation rate (per cent)	80.07
	Average time spent for meeting per year (hr)	1.26

Source: Primary household survey (2014-2015).

It is evident from the table that average number of meetings be it general body, executive or special meetings conducted in a year is nearly two. Date of meetings was informed to the members through phone. The average participation rate was 80 per cent in all the cases. The time spent in the meetings (at least 1.5 hrs) would reveal the depth of the issue discussed.

Household Contribution in Canal Maintenance Activities

The results detailed in the Table 6 deals with the type of contribution by the farm

TABLE 6. DETAILS OF THE CONTRIBUTION BY FARMERS

Collective contribution (1)	Repair and maintenance (2)	Channel cleaning (3)	Bund strengthening (4)	Removal of encroachment (5)	Diversion of water from upstream (6)	Others (bribing for getting supplies, meetings) (7)	Average (8)
Frequency of collective action (time per year)	1	1	1	1	1	1	1
Participation (number per WUA)	3.28	6.19	7.37	9.50	8.91	2.16	6.24
Participation (days per household per activity)	4.79	5.19	6.25	3.6	4.90	2.31	4.51
Labour contribution (person days per year)	5.89	6.69	6.81	6.55	7.90	3.59	6.24
Total value of labour spent on all the activities (Rs./ha)	60.22	68.40	69.31	66.97	80.77	36.70	63.73
Cash contributed for canal maintenance (Rs./ha)	35.78	35.17	51.12	61.34	71.57	40.89	49.31
Monetary contribution (Rs. per year per household)	12.32	12.11	17.61	21.12	24.64	17.60	17.57
Total monetary value of contribution for Canal maintenance (Rs./ha of command area)	96.00	103.57	120.43	128.31	152.34	77.59	113.04

Source: Primary household.

households. The respondents indicated that at least once the canal maintenance activity was done. These respondents contributed differently either in terms of labour or in terms of cash. The participation of farmers in man-days per household per activity varied from 2 to 9. Nearly 9 man-days were required for the removal of encroachment.

It was also reported that the poorer farmers contributed in terms of labour while the others in terms of cash. Some of the farmers cleaned up the field channels on their own. Surprisingly it was reported that the main canal cleaning and desiliting was done by the NREGA workers as arranged by the respective panchayats. Interestingly in some areas it was observed that these farm household waited for the workers to clean up the canal so that they can get canal water. The labour contribution in man-days per year was on an average 6.24. Nevertheless the total value of labour contributed for each activity was assessed in terms of the opportunity cost of labour. The daily wage rate available in the area was taken as proxy.

On an average the total value of labour contributed accounted for nearly Rs. 63. The cash contributed for the maintenance work by the farmers on average accounted for Rs. 49/ha. It could be seen from the table that much of the attention was given to the diversion of water and removal of encroachment. Monetary contribution per household was also assessed which summed to Rs. 17.57 on average. The total monetary contribution for canal maintenance was Rs. 113.04 /ha/yr. Bribing for water (nearly Rs. 40/ha) was also reputed from some areas.

Descriptive Statistics of the Variables Studied

Given the hypothesised effect of household and community-level variables, a hasty testing of different variables under study between members and non-members provides a useful baseline from which initial comparisons can be drawn and hypotheses tested. Descriptive analysis can uncover stark differences between the members and non-members (Table 7).

The average age of the household head who were members in WUA is 51 years as compared to the non-members with 57 years of age. The standard deviation is 8.05 for members. It is worth mentioning that the education level of the household head among the members was primary or secondary whereas the non-members have primary level of education. Most of the farms in the WUAs were located at least in the middle or tail from the head works of the canal. It has been found that these farms located far away from the canal are least benefitted from water distribution.

It was revealed from the table that there was significant difference between the land owned by the members (1.88) and non-members (1.36) which was considerably fragmented. It has been found that member households meet the concerned officials at least thrice a year to get support. For the smaller subset with functioning WUAs, economic heterogeneity, was captured by the land difference between the WUA (0.65).

TABLE 7. DESCRIPTIVE STATISTICS OF THE VARIABLES STUDIED

Variables (1)	Number of observations (2)	Mean (3)	SD (4)	Min. (5)	Max. (6)
Functioning					
AGE	142	51.40	8.05	35.00	75.00
EDUCATIONH	142	2.95	0.75	2.00	4.00
LFIELD	142	3.03	0.81	1.00	3.00
NFINCOME	142	8503.30	581.29	7509.00	9476.00
FSIZE	142	1.88	0.62	0.32	2.49
ROLE	142	1.68	1.12	1.00	2.00
CONTACT	142	3.13	1.41	1.00	5.00
GINI	142	0.65	0.27	0.02	0.92
GSIZE	142	47.65	15.76	22.00	79.00
INFINDEX	142	5.58	2.02	1.19	9.24
Non-Functioning					
AGE	131	57.82	12.97	34.00	84.00
EDUCATIONH	131	1.95	0.45	2.00	4.00
LFIELD	131	2.05	0.81	1.00	3.00
NFINCOME	131	5936.63	578.90	5020.00	6976.00
FSIZE	131	1.36	0.54	0.32	2.19
ROLE	131	0.00	0.00	0.00	0.00
CONTACT	131	2.90	1.40	1.00	5.00
GINI	131	0.36	0.28	0.02	0.92
GSIZE	131	0.00	0.00	0.00	0.00
INFINDEX	131	4.16	1.89	1.97	11.29

Source: Primary household survey (2014-2015).

A WUA on an average has 47 members with a standard deviation of 15.76 when compared with non-functioning association. The infrastructure of a functioning WUA on an average was worked out to be 5.60 against 4.46 of non-functioning WUA.

Household Participation in Canal Maintenance Activities

Tables 8 and 9 present the Heckman two-step estimator results from the contribution process. The first specification indicates that the variables age of the water user association, location of the field, non–farm income, gini coefficient and group size affects a household decision to participate in yearly canal maintenance activities.

The variable LFIELD was found to be significantly affecting participation of the household in canal maintenance. It could be seen that users with better water supply had less need for lobbying and the households at the tail end are more active in canal maintenance (Meinzen-Dick, 2007). The community level factor GINI which measured the command area under each WUA was found to be significant at 10 per cent. It could be interpreted that there was a U-shaped relationship between inequality in land ownership and the extent of cooperation, which is in conformity with the results obtained by Bardhan (2000) and Balasubramanian and Selvaraj (2003).

TABLE 8. PARTICIPATION IN CANAL MAINTENANCE ACTIVITY BY MEMBERS OF WUA

Variable	Participate	Contribution (Rs.)
(1)	(2)	(3)
CONSTANT	22.01	670.46
AGE	0.001*	0.012
	(3.12)	(0.0047)
EDUCATIONH	0.04	0.018
	(4.89)	(0.25)
LFIELD	0.01**	2.76***
	(1.69)	(0.17)
NFINCOME	- 115.12*	- 0.14*
	(7.92)	(10.67)
FSIZE	- 0.101	- 0.39
	(0.11)	(0.02)
ROLE	0.16	0.18
	(18.73)	(23.12)
CONTACT	5.15	3.30
	(1.26)	(0.48)
GINI	- 0.33*	- 164.71*
	(1.62)	(4.75)
GSIZE	- 0.001*	
	(3.61)	
INFINDEX	0.04	3.17
	(1.48)	(4.38)
IMR		443127*
		(0.001)
Number of observations	273	273
R square	0.77	0.80
F value	56.71	98.12

Source: Primary household survey (2014-2015).

Note: Figures in parentheses indicate estimated t ratios, ***, ** and * indicate values are significant at 1, 5 and 10 per cent level respectively.

The group size has negative influence on the extent of collective action probably due to the fact that the larger WUAs involve a higher number of beneficiaries. This would increase heterogeneity that discourages cooperative action among farmers (Balasubramanian and Selvaraj, 2003). The household level factor NFINCOME showed negative contribution in farmer participation towards canal maintenance with ten per cent significant level (Nanthakumaran and Palanisami, 2010 and Balasubramanian, 2006).

The estimate of the Inverse Mills' Ratio in the regression model was statistically significant and had positive sign, suggested that participation in canal maintenance and labour/monetary contributions were positively correlated. Inclusion of Inverse Mills Ratio in the specification corrects for the selection bias and the significance of the other regressor (Pattanayak 1998). The results from Table 9 revealed that the contribution is influenced by location of the field, non–farm income, gini coefficient and group size of WUA.

At the community level, the size of the WUA negatively affects the probability that a household will contribute labour or money. The effect of size of WUA on contribution by the members is consistent with the expectations in group theory and

conventional thinking suggest that collective action is difficult as group size increases (Araral, 2009).

The findings on the effect of location of the field suggest that it had positive, strong and statistically significant effect on contribution for canal maintenance. Wade (1987) concluded that villagers were likely to follow joint rules and arrangements only to achieve intensely felt needs that could not be met by individual actions, seeming to imply a positive relationship between water scarcity with location as proxy and collective action. Bardhan (1993a) argued that the likelihood of collective action was largest at moderate levels of natural resource scarcity, while at high levels of scarcity and ecological stress institutional arrangements break down as people scramble for survival and discount rates increase. This implied a nonlinear relationship revealing that scarcity of resources, as measured by people per unit of resource, does not appear to encourage formation of management institutions and to its contribution (Heltberg, 2001).

Regarding the effect of non-farm income the findings indicate that it had a strong negative relationship with the contribution to yearly maintenance activities. This finding is reinforced by anecdotal evidence from the study area and literature stating that income from non-farm sources will reduce the dependency of farm households on WUA and enable the household to increase the income on the other hand (Suresh Kumar, 2010). The result is also consistent with hypothesised expectation the variable will have negative effect on household decision to participate in collective action.

The variable GINI used as a proxy for inequality in wealth of WUA indicated that the relationship between inequality and collective action reveals no definite clues about the direction of its impact (Bardhan, 2000). The regression coefficients for inequality in land ownership revealed that there was an inverted U-shaped relationship between wealth inequality and participation in collective action and hence its contribution.

Table 9 presents the results from three different OLS specifications for farm revenues. The signs on all the coefficients were mostly consistent with expectations, yet only education of the household head, location of the field, non-farm income, gini coefficient, infrastructure index and group size were statistically significant. At the household level, education of the household head, non-farm income and location of the field have statistically significant effect on revenue, seeds and fertilisers respectively whereas role of the household head in WUA and contact with other association members was found to have a positive and significant effect on farm revenue. Gini coefficient a proxy for inequality negatively influences the seed obtained and positively affects the amount of fertilisers obtained by the association. With regard to infrastructure index, it had a positive and significant influence on farm revenue of the farmers.

TABLE 9. PARTICIPATION IN CANAL MAINTENANCE ACTIVITY BY MEMBERS OF WUA AND ITS IMPACT ON INCOME

Variables	Seed	Fertilisers	Farm revenue
(1)	(2)	(3)	(4)
Constant	520.64	7908.11	- 12466.9
	(39.70)	(17.72)	(- 1.46)
AGE	2.68	8.55	- 136.49
	(1.59)	(2.31)	(0.32)
EDUCATIONH	0.202**	148.83**	337.53**
	(2.03)	(2.23)	(0.32)
LFIELD	- 3.64**	-169.74*	- 4441.17
	(- 2.199)	(- 2.69)	(-4.54)
NFINCOME	- 0.017*	- 0.29*	8.836
	(- 12.99)	(- 5.23)	(9.92)
FSIZE	2.00	- 21.28	- 1893.21
	(1.18)	(-0.33)	(-1.72)
ROLE	- 2.48	- 809.13	2073.54**
	(- 2.02)	(- 13.09)	(2.63)
MEETING	1.52	- 19.72	1056.79*
	(1.64)	(- 0.69)	(2.63)
GINI	-13.38*	397.90**	2582.12
	(- 3.29)	(2.08)	(1.01)
INFINDEX	- 1.36	9.78	712.16**
	(-2.53)	(0.466)	(1.99)
GSIZE	- 15.33	- 0.30	167.83*
	(4.68E-06)	(2.03E-05)	(3.56)
Number of observations	273	273	273
R square	0.83	0.84	0.89
F value	158.96	112.64	98.47

Source : Primary household survey (2014-2015).

Note: Figures in parentheses indicate estimated t ratios, ***, ** and * indicate values are significant at 1, 5 and 10 per cent, respectively.

To summarise, older, more educated households with greater managerial capacity earn more revenues on average. At the community level, households located in larger WUA with a well-connected WUA president had higher farm revenues. But in WUAs whose members were far away from the head work, revenues were lower, as water scarcity appeared to impose a cost on community members.

V

CONCLUSION AND POLICY IMPLICATIONS

As devolutionary policies through institution building become widely adopted across the world, it becomes important to understand the circumstances under which these policies succeed.

The participation of farmers in man-days per household per activity varied from two to nine. It was also reported that the marginal farmers contributed in terms of labour while the others in terms of cash. The labour contribution in man days per year was on an average 6.24. On an average the total value of labour contributed accounted for nearly Rs.63/ha. The cash contributed for the maintenance work by the

farmers on average accounted for Rs.49/ha. On average monetary contribution per household was Rs.17.57/ha. The total monetary contribution for canal maintenance was Rs.113.04/ha/yr.

An analysis of the household contribution for canal maintenance indicated that the variables like age of the water user association, location of the field, non–farm income, gini coefficient and group size affects a household decision to participate in yearly canal maintenance activities. On an average older, more educated households with greater managerial capacity earn more revenues. At the community level, households located in larger WUA with a well-connected WUA president had higher farm revenues.

It could be seen that the funds allocated were inadequate for the maintenance of the canal and field channels. Many of WUAs have become defunct in later years. Hence it is suggested that cost sharing mechanism by farmers for canal maintenance if introduced, would enhance responsibility among the farm households and all the WUAs would function effectively. Furthermore, the group heterogeneity implied the cost that the WUA have to bear on canal maintenance funding, activities, and thus factor expenditures and farm revenues. Hence the local conditions and stakeholders views and suggestions about the ways and means of restoring the system is the need of the hour to ensure its sustainability. It was also reported that the farmers were unaware of different management practices. Hence, capacity building training for the farmers to make aware of the irrigation management practices and roles and responsibilities of different office bearers of WUAs would ensure better management of canal irrigation system.

NOTE

1. Infrastructure Index was constructed based on different indicators like length of roads, number of post offices, number of telephone exchanges and number of buses operating in the area. Iyengar and Sudarshan method was used to work out the composite index of infrastructure

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